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Full Length Research Paper

Length-weights relationships and relative weights of some demersal fish species from the Persian Gulf, Iran

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This study reports the Length-weights relationships, and relative weights of 5 demersal fish species of Persian Gulf. Specimens were caught during fishing surveys using different types of fishing gears between April 2008 to December 2010. A total of 653 individuals were sampled. The parameter *b* ranged between 2.626 (*Acanthopagrus latus* (Houttuyn, 1782)) to 2.995 (*Carangoides talamparoides* (Bleeker, 1852)). The coefficient of determination (r^2) was very significant for all the species. Relative weight differed significantly (Kruskal-Wallis test, P< 0.001) with best performance by *Saurida tumbil* (Bloch, 1975) and *Nemipterus japonicus* (Bloch, 1791). *Otolithes ruber* (Bloch and Schneider, 1801) showed 90% mean weight calculated for this species. To the authors' knowledge, the length-weight relationships and the Relative weights presented for *N. japonicus, C. talamparoides* and *S. tumbil* are reported for the first time from the Persian Gulf, but *A. latus* and *O. ruber* have not been previously reported for the Iranian water fishes.

Key words: Persian Gulf, length-weights relationships, relative weights, demersal fish species.

INTRODUCTION

The Persian Gulf is in the subtropical zone, lying almost completely between the latitudes 24° and 30° N and longitudes 48° and 56° 30′E (Figure 1). The waters of the Persian Gulf are environmentally unique with an unusual faunal assemblage (Carpenter et al., 1997).

Nemipterus japonicas (Bloch, 1791), *Acanthopagrus latus* (Houttuyn, 1782), *Carangoides talamparoides* (Bleeker, 1852), *Saurida tumbil* (Bloch, 1975) and *Otolithes ruber* (Bloch and Schneider, 1801) are among the important groups of demersal fishes landed by commercial and artisanal fisheries in Iranian waters. Fishery data show a 21% decrease for demersal fish in landings from 110,000 tonnes in 2002 to 87,240 tonnes in 2003 (Planning and Development Department, 2003). Therefore, these species of fish is classified as over-exploited in the Persian Gulf (Valinassab, 2006). Among various biometric relations in fishes, the Length weights relationships (*WLR*) are greatly presented by researcher as functional tools with several applications in the fields of fisheries research, ecology, population dynamics, and stock assessment (Pauly, 1993; Erzini, 1994; King, 1995; Petrakis and Stergiou, 1995; Santos et al., 2002; Ferreira et al, 2008). The Length-weights relationships (LWR) have also been used for estimating the weight at a given length.

Relative weight as management goal is considered by fisheries management and used for monitoring condition of fishes and for comparative growth studies. Relative weight is also a suitable index for comparing condition across populations and species (Froese, 2006).

Length-weights relationships (LWRs) are still scarce for most tropical and sub-tropical fish species (Harrison, 2001; Ecoutin et al., 2005; Hossain et al., 2010). The aim

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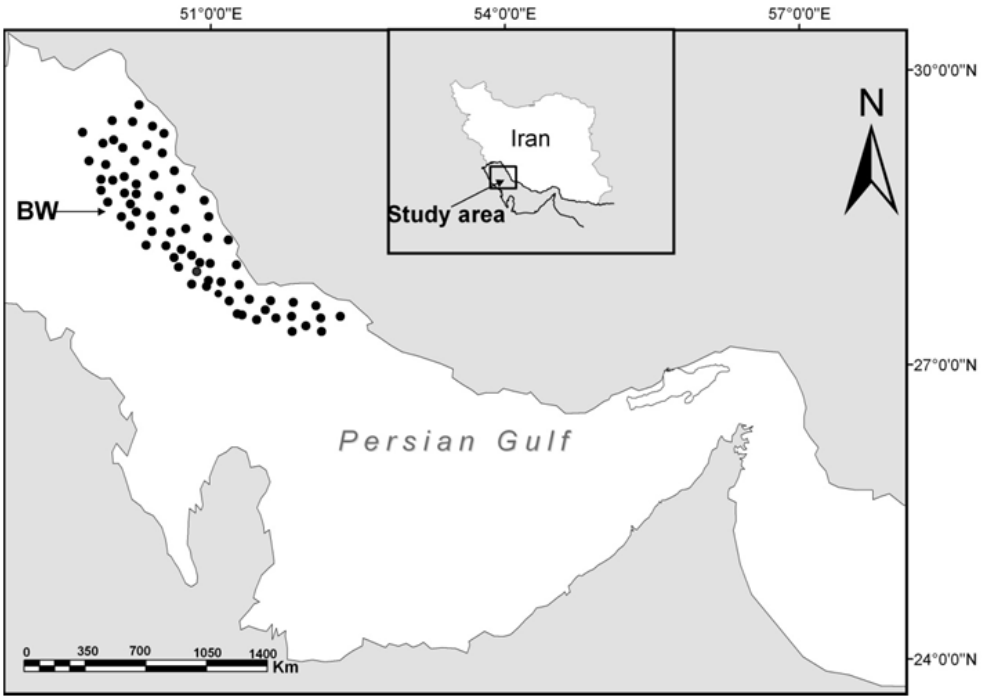

Figure 1. Map of the study area in Persian Gulf, Black dots indicate locations of sampling. BW= Bushehr waters.

of the present study was to determine *LWR*s for this five species in the fishing grounds of Persian Gulf.

MATERIALS AND METHODS

The study area was restricted to Iranian waters of the Persian Gulf, between latitudes 27°15′-30°16′ N and longitudes 49°54′-52°30′E (SW of the Persian Gulf, Figure 1). Data were collected on monthly basis during April 2008 to December 2010 of fishing research surveys. The specimens were caught by several different types of fishing gear: (i) bottom trawl with mesh size 40 mm (STR) in the cod end; (ii) gill nets with mesh sizes, 80, 90, 100, 130 and 140 mm (STR) and (iii) pot nets. Subsequently, the collected samples were considered to represent the spatial and depth range of the study region adequately (Figure 1). Trawl duration ranged from 1 to 3.5 h (mean 2.7±0.2 h) at speeds of about 3.2 knots and were restricted to 30 m depth.

The fish length was estimated to the nearest lower millimeter and the weight was measured with an accuracy of 0.1 g. The *W-L* relationship was estimated by using the equation:

$$W = aL^b$$

Where *W* is the whole body weight (g), L is fork length (cm). Parameters *a* and *b* of the weight-length relationship was estimated by linear regression analysis based on logarithms:

log (W) = log(a) + b log(L).

The 95% confidence limits of parameters *a* and *b* and the coefficient of determination r^2 were also calculated. To demonstrate significant difference of obtained *b*-value in equation from the isometric value 3, a t-test was used, expressed by the following equation (Sokal and Rohlf, 1987):

$$t_s = \frac{b-3}{s_b}$$

Where t_s is the t-test value, *b* the slope and s_b the standard error of the slope (*b*). Comparison between obtained values of t-test and the respective tabled critical values allowed the determination of the statistically significant *b* values, and their inclusion in the isometric range (*b*=3) or allometric range (negative allometric; *b*<3 or positive allometric; *b*>3).

Where *W* = whole body wet weight in grams and L = fork length in grams (Froese, 2006). The relative weight (W_{rm}) was calculated using the given formula by Froese (2006):

$$\mathrm{W_{rm}} = 100\frac{W}{a_m L^b}$$

$$\log a_{gm} = \frac{1}{N}\sum_{\mathrm{i}=1}^{\mathrm{N}} \log a_i$$

Where *W* is weight of specimen (g), *L* is fork length of specimen (cm), a_m is geometric mean *a*, and b_m is mean *b* across all available, non-questionable Length-weights relationship estimates for a species as parameters of the mean Length-weights relationship that is cited in Fishbase (Froese, 2006), N is number of parameter *a* and *b* that is available in Fishbase. Kolmogrov-Smirnow and Levene tests were used to analyze normality of the data and homogeneity of variances, respectively (Zar, 1999). Since, the assumptions of parametric statistics could not be met, a non-

Table 1. Descriptive statistics and WLR parameters for five demersal fish species of Persian.

Family/species	n	Length (cm)				*WLR* parameters and statistics						
		Mean	S.E	Min	Max	*a*	SE(a)	95%CL(a)	*b*	SE(*b*)	95%CL*b*	r^2
Nemipteridae												
Nemipterus japonicas	95	20.14	0.099	7.3	24.5	0.0517	0.099	0.0328-0.0813	2.664	0.076	2.513-2.815	0.928
Sparidae												
Acanthopagrus latus	91	22.41	0.331	9.5	32.4	0.0816	0.081	0.1191-0.1190	2.626	0.062	2.503-2.749	0.952
Carangidae												
Carangoides talamporoides	285	21.87	0.275	14.2	47.5	0.0184	0.067	0.0136-0.0251	2.995	0.051	2.895-3.094	0.926
Synodontidae												
Saurida tumbil	92	30.72	0.447	24.4	45.3	0.0417	0.137	0.0229-0.0758	2.586	0.872	2.412-2.761	0.907
Sciaenidae												
Otolithes ruber	90	36.27	0.483	29.6	50.1	0.0153	0.114	0.0091-0.0250	2.890	0.073	2.744-3.035	0.946

Gulf (n: sample size, S.E: standard error; Min: minimum, Max: maximum, *a* and *b*: parameters of equation $W = aL^b$, CL 95%: confidence limits, r^2: coefficient of determination).

parametric Kruskal–Wallis test with a 5% level of significance was used to find the significant differences in mean W_{rm} between the species. All the statistical analyses were considered at a significance level of 5% (P<0.05).

RESULTS

A total of 653 samples of five fish species were collected from the Bushehr waters of the Persian Gulf. In numerical terms, the most important species was *C. talamparoides* with 285 individuals. Minimum and maximum observed total length (TL) of all the samples belong to *N. japonicus* and *O. ruber* with 7.3 and 50.1 cm, respectively (Table 1). The *L-W* relationships were significant (p < 0.05) for all the five species. The *b* value ranged from 2.626 (*A. latus*) to 2.995 (*C. talamparoides*). The mean *b* value for all the species was 2.752. All relationships were highly significant (P<0.001), with coefficient determination (r^2) values being greater than 0.907.

The growth was negative allometric (*b*<3, P<0.001) for *N. japonicus*, *A. latus* and *S. tumbil*. *C. talamparoides* and *O. ruber* indicated isometric growth (b =3, P > 0.05).

Relative weight (W_{rm}) differed significantly between all the species (Kruskal-Wallis test, P< 0.001) with best performance by *S. tumbil* followed by *N. japonicus* and *A. latus* estimated as 1.481±0.064, 1.456±0.010, 1.025±0.008, respectively (Table 2, Figure 2).

DISCUSSION

In this study, a large number of samples were captured by different fishing gears, such as trawls, pots and gill nets of different mesh sizes. Due to non-selective fishing technique, such as trawl, samples with different body size were captured. The differences in fish sizes display that the fish population ranged from immature specimens to fully matured ones (Fifioye and Oluajo, 2005). Result of this study shows a suitable estimation of Length-weights relationships, whereas parameter *b* lay between the expected ranges of 2.5-3.5 (Froese, 2006).

There have been some studies on length-weight relationships of these species in the Persian Gulf and other locations (Table 3). The values of the scaling exponent *b* for five species (Table 3) ranged from 2.334 (*O. ruber*) to 3.396 (*S. tumbil*) and our results remained within the given range. For some of the studied species, such as *C. talamparoides* and *S. tumbil*, the *b* values were not generally in agreement with previous results. It

Table 2. Relative weight (W_{rm}) of five demersal fish species from the Persian Gulf, during April 2008 to March 2010.

Family/species	Relative weight (W_{rm})								
	n	a_m	b_m	SE(b_m)	Mean	S.E	Min	Max	95%cl
Nemipteridae									
Nemipterus japonicas	95	0.0177	2.897	0.050	1.4562	0.037	1.8559	1.2172	0.0734
Sparidae									
Achanthopagrus latus	91	0.0503	2.758	0.069	1.0254	0.008	0.822	1.263	0.0174
Carangidae									
Carangoides talamporoides	285	0.0239	2.927	0.033	1.001	0.009	0.3929	1.5698	0.018
Synodontidae									
Saurida tumbil	92	0.0046	3.179	0.078	1.481	0.064	0.7317	3.851	0.120
Sciaenidae									
Otolithes ruber	90	0.0322	2.714	0.136	0.9004	0.008	0.7229	1.1093	0.0160

n: Sample size, a_m: geometric mean, b_m: mean b, standard error; Min: minimum, Max: maximum.

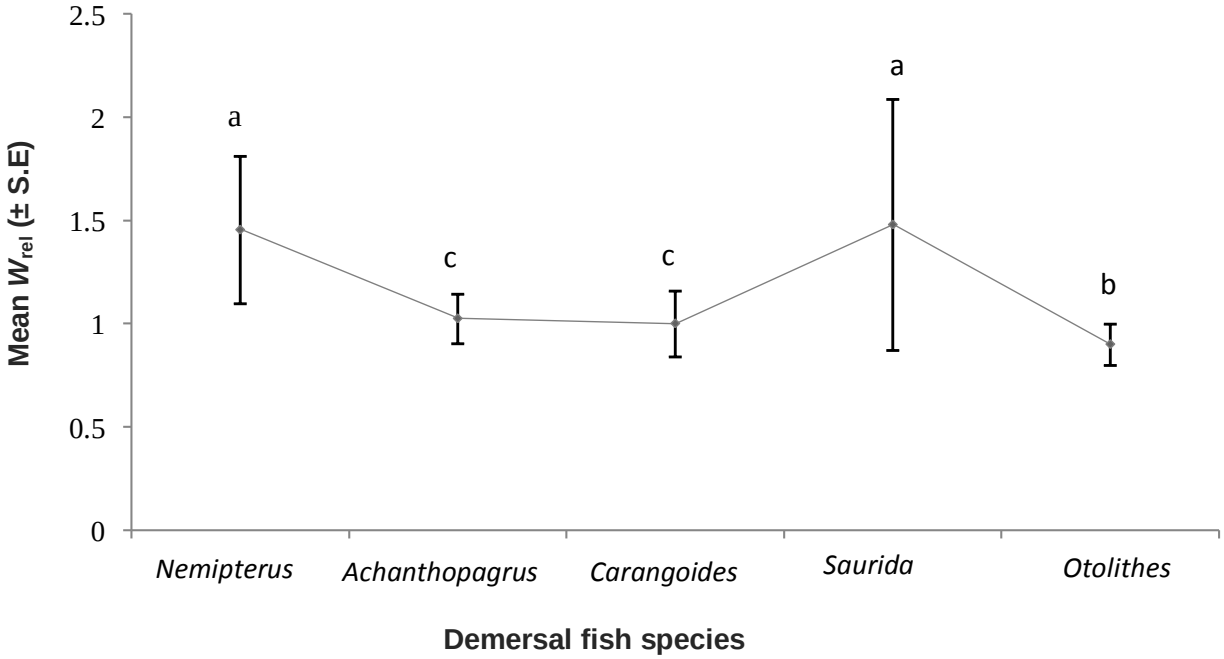

Figure 2. Mean W_{rel} (± S.E) for five demersal fish species from the Persian Gulf. Means that differed significantly in Kruskal-Wallis test indicated by a,b,c.

is well known that the functional regression *b* value represents the body form, and it is directly related to the weight affected by ecological factors, such as temperature, food supply, spawning conditions and other factors, such as sex, age, fishing time and area and fishing vessels (Ricker, 1973).

LWRs are not constant over the year and LWRs parameter may vary significantly due to biological, food availability, temporal and sampling factors, health and sex (Bagenal and Tesch, 1978; Froese, 2006); however, all were not considered in this study. Since all the samples were collected over several seasons, data

Table 3. Some study result of length-weight relationship for fish species in different area.

Species	Length Min-Max	a	b	Location	References
Nemipterus japonicas	7.6-26.1	0.058	2.666	Gulf of Aden	Al Sakaff and Esseen (1999)
	-	0.028	2.702	Visakhapatnam	Murty et al. (1992)
	-	0.029	2.730	Peninsular west coast	Ahmad et al. (2003)
	8.5-22.4	0.013	2.966	Madras	Vivekanandan and James (1986)
Acanthopagrus latus	9.2-34.5	0.054	2.858	kuwait	Hussain and Abdullah (1977)
	-	0.028	2.792	kuwait	Samuel and Mathews (1987)
Carangoides talamporoides	6-21.5	0.0114	3.319	Australia	Willing and Pender (1989)
Saurida tumbil	12.1-32.5	0.0036	3.201	India	Rao (1983)
	11.2-50.3	0.0027	3.396	southern East China Sea	Tzeng et al. (2002)
	-	0.0190	2.866	Bay of Bengal	Mustafa (1999)
Otolithes ruber	14.2-45.5	0.020	2.916	Kuwait	Hussain and Abdullah (1977)
	-	0.022	2.790	South Africa	van der Elst (1981)
	21.8-42.5	0.158	2.334	Yemen	Al Sakaff and Esseen (1999)

obtained does not represent a specific season of the year. The parameters *a* and *b* should be considered only as mean annual values.

Relative weight in fisheries study is used for comparing conditions across different populations and species (Froese, 2006). Results for relative weights of *N. japonicus*, *A. latus*, *C. talamparoides* and *S. tumbil* showed that these species had surpass 100% of the mean weigh calculated via other studies for this species suitable condition during this study (2008–2010). But relative weights for *O. ruber* showed 90% mean weight calculated for this species. Valinasab et al. (2006) reported that *N. japonicus*, *S. tumbil* and *C. talamparoides* were most abundant commercial fish in the Persian Gulf, but *O. ruber* constituted a very small proportion of the total catch.

For *N. japonicus, C. talamparoides* and *S. tumbil*, no LWRs were reported in the commercial fisheries of demersal fishes inside the Persian Gulf, and as such, *A. latus* and *O. ruber* has not been previously reported for the Iranian water fishes. This study also presented the basic information on the Length-weights relationships and conditions for these species from Persian Gulf, which would be useful for fishery managers as well as the sustainable management of its numerous resources in the region.

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